Summary of "SUSY and new physics at the Terascale" session

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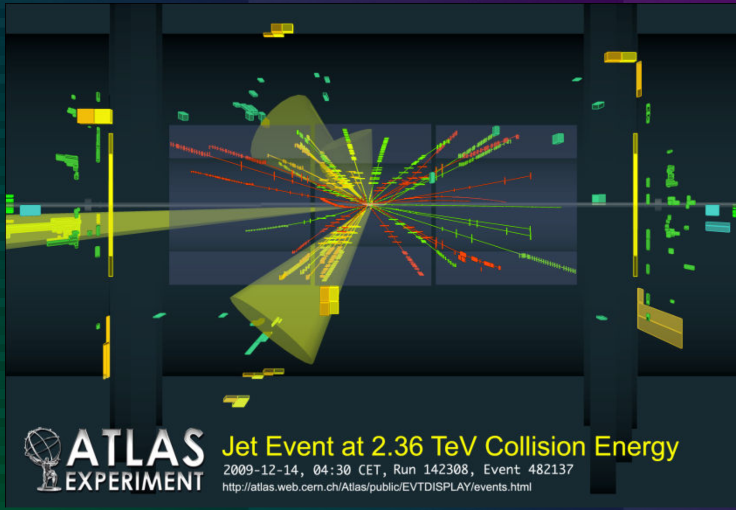
Excuse me if there are misunderstanding or prejudices in this summary, esp. for theoretical issues.

New Physics @ ILC

- LHC has restarted just now – exciting days will come!
  - In spite of the lower energy & lumi. than expected, LHC will certainly open a window for the terascale new physics.
  - Results for the new physics probably come earlier than Higgs (have to wait till ~2015 for SM light Higgs?).
- LHC=discovery, ILC=identification
  - After the discovery of new physics, ILC can play a critical role to identify the new physics.
    - Masses/Spins/Couplings/etc…
    - Need to investigate wide range of new models – should not stick to SPS1a'/mSUGRA/SUSY



Overview of the SUSY/NP Sessions

- 12 talks in 3 sessions for SUSY/NP
  & 8 talks in 2 joint sessions with Higgs/EWSB
  - 27 (Sat.) Afternoon (2 sessions, 8 talks)
  - 28 (San.) Afternoon (2 joint sessions, 8 talks)
  - 29 (Mon.) Morning (1 session, 4 talks)
- Covered themes (wo/ joint session)
  - SUSY (3 talks): Squarks/gluinos, MSSM/NMSSM, Point5
  - WIMP-only (2 talks)
  - Model ID by spin (2 talks)
  - UED (2 talks)
  - Others (2 talks) Gauge coupling, Left-right symmetric
  - SB2009 for new physics (1 talk)

Titles & Speakers

Normal session:

Light squarks and gluinos at TeV e+e- collider
by Tom RIZZO (SLAC)

Distinguishing the NMSSM from the MSSM at the ILC using Fittino by Anthony HARTIN (DESY)

Chargino and neutralino masses at ILC
by Yiming LI (University of Oxford)

Using single photons for new physics at the ILC
by Koichi MURASE (University of Tokyo)

Measurement of right-handed neutrino in extra dimension model at ILC
by Tomoyuki SAITO (Tohoku University)

Signals of universal extra dimension at the linear collider by Biplob BHATTACHERJEE (Tata Institute of Fundamental Research)

Precision test of gauge boson self couplings at ILC
by Lei GUO (USTC)

Independent WIMP searches in full simulation of the ILD detector by Christoph BARTELS (DESY)

Identification of new physics and general WIMP search at the ILC by Masaki ASANO (Tohoku University)

Simulation study of W + DM signature for identification of new physics models
by Taikan SUEHARA (University of Tokyo)

Decaying dark matter in a left-right symmetric model
by Yu-Feng ZHOU (ITP, Chinese Academy of Sciences)

The impact of currently discussed design issues on the 'new physics searches' potential of the ILC by Mikael BERGGREN (DESY)

Joint session:

Aspects of Higgs searches in CP-conserving and CP-violating SUSY scenarios at the LHC and ILC
by Priyotosh BANDYOPADHYAY (KIAS)

New Physics Contribution to Neutral Trilinear Gauge Boson Coupling by MAMTA (University of Delhi)

Observing the coupling between dark matter and higgs boson at the ILC
by Shigeki MATSUMOTO (University of Toyama)

New Physics effect on Higgs boson pair production processes at LHC and ILC by Daisuke HARADA(KEK)

What can we learn from early LHC data on new physics models? (a summary talk of the corresponding working groups of the LHC2FC workshop)
by Christophe GROJEAN (CERN)

Testing the Higgs sector in radiative seesaw models at the ILC by Shinya KANEMURA (Toyama University)

Analysis of Little Higgs Model with T-parity at the ILC
by Yosuke TAKUBO (Tohoku University)

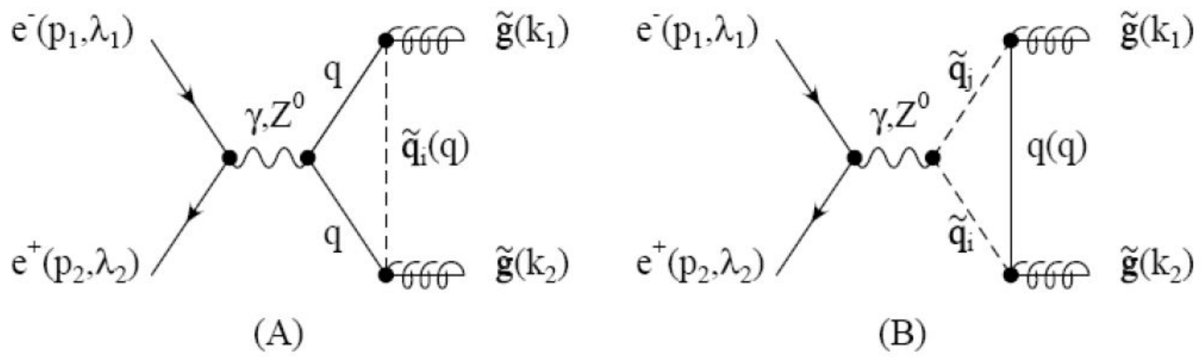
What can we learn from top physics and electroweak physics at the Z-pole/WW-threshold on new physics models? by Sven HEINEMEYER (Cantabria Inst. Phys.)

SUSY talks

T. Rizzo, A. Hartin, Y. Li

2 Theory talks:

- Light squarks and gluinos at TeV linear collider
- Distinguish MSSM & NMSSM



Berge & Klasen

Squarks and gluinos can be directly produced at TeV linear collider (cross section is very small)

There is a point where NMSSM gives similar mass spectrum to MSSM: higher CM energy needed for separation

	MSSM	NMSSM
M_1	375 GeV	360 GeV
M_2	152 GeV	147 GeV
$\tan\beta$	8	10
μ	360 GeV	-
μ_{eff}	-	457.5 GeV
κ	-	0.2
Mass($\tilde{\chi}_1^0$)	138 GeV	138 GeV
Mass($\tilde{\chi}_2^0$)	344 GeV	337 GeV
Mass($\tilde{\chi}_1^\pm$)	139 GeV	139 GeV
Mass($\tilde{e}_L$)	240 GeV	240 GeV
Mass($\tilde{e}_R$)	220 GeV	220 GeV
Mass($\tilde{\nu}_e$)	226 GeV	226 GeV

SUSY talks

T. Rizzo, A. Hartin, Y. Li

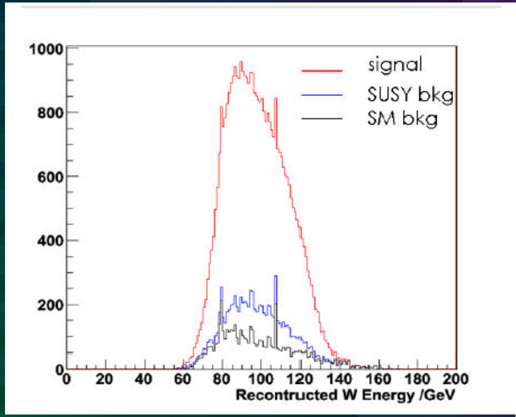
1 Experimental talk:

- SUSY point5: chargino and neutralino separation with SiD detector (one of LoI benchmark processes)

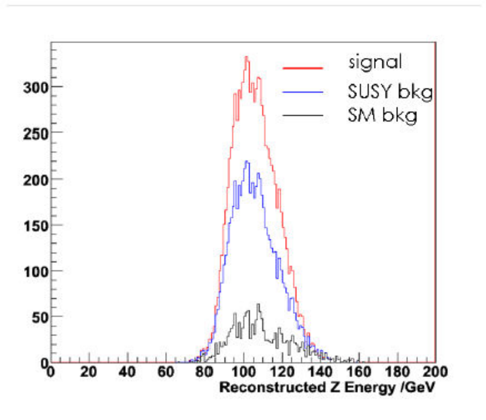
$$e^+e^- \to \tilde{\chi}_1^+\tilde{\chi}_1^- \to \tilde{\chi}_1^0\tilde{\chi}_1^0 W^+W^- \to \tilde{\chi}_1^0\tilde{\chi}_1^0 q\bar{q}q\bar{q}$$

$$e^+e^- \to \tilde{\chi}_2^0\tilde{\chi}_2^0 \to \tilde{\chi}_1^0\tilde{\chi}_1^0 Z^0Z^0 \to \tilde{\chi}_1^0\tilde{\chi}_1^0 q\bar{q}q\bar{q}$$

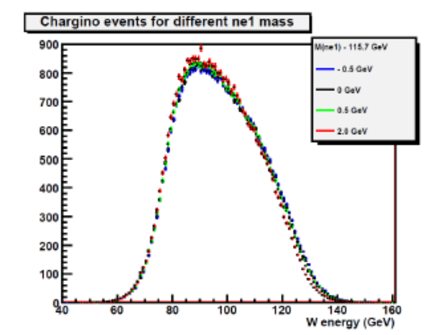
parameter	value
m_0	206 GeV
$m_{1/2}$	293 GeV
tan β	10
A	0
μ	375 GeV
$M_{\tilde{\chi}_1^0}$	115.7 GeV
$M_{\tilde{\chi}_1^\pm}$	216.5 GeV
$M_{\tilde{\chi}_2^0}$	216.7 GeV

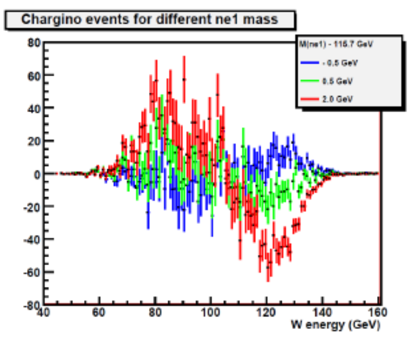


chargino



neutralino





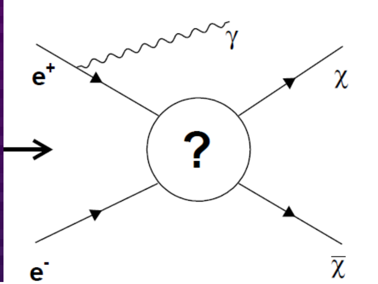
Template fit

$\tilde{\chi}_1^+\tilde{\chi}_1^-$	
$\tilde{\chi}_1^\pm$	472 MeV
$\tilde{\chi}_1^0$	156 MeV
$\tilde{\chi}_2^0\tilde{\chi}_2^0$	
$\tilde{\chi}_2^0$	$\gtrsim 2 GeV$
$\tilde{\chi}_1^0$	279 MeV

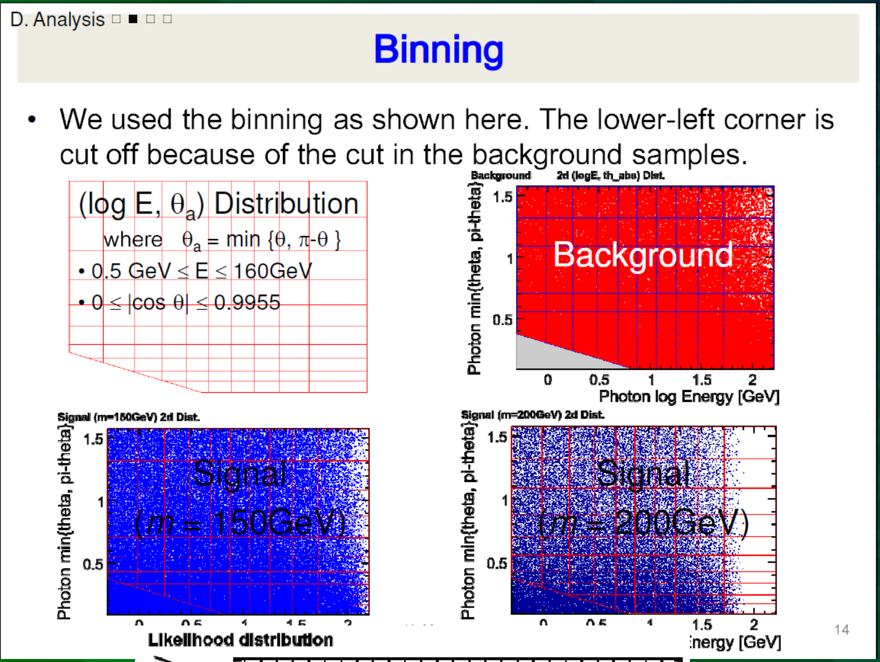
WIMP-only Talks

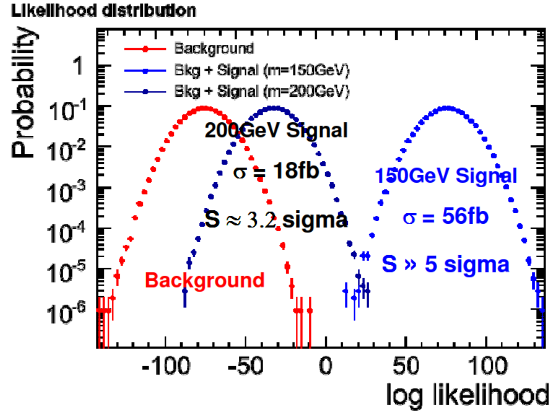
K. Murase, C. Bartels

Scenario "all but DM-pair (with ISR) cannot be observed".

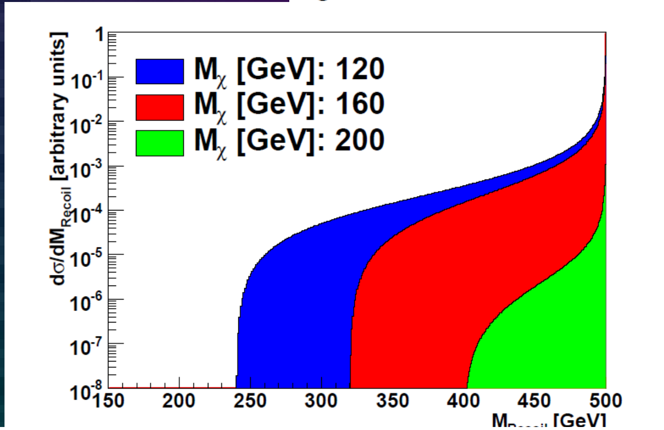


1. Cross section limit (with ννγ background)



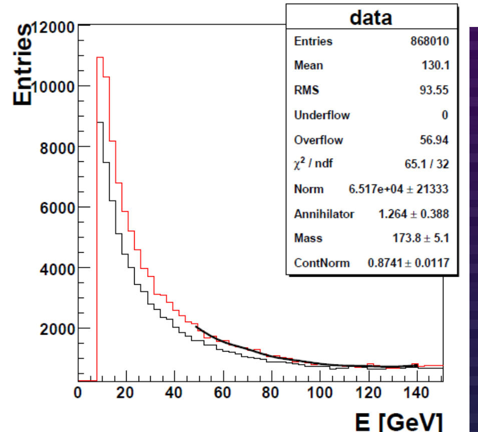


2. Mass determination



M_{in}: 180 GeV; J_{in}: 1

- $M = 173.8 \pm 5.1$ GeV
- $J = 1.264 \pm 0.338$
- J = 0 excluded
- First attempt, only one model point
- Improvements expected with better description of background shape

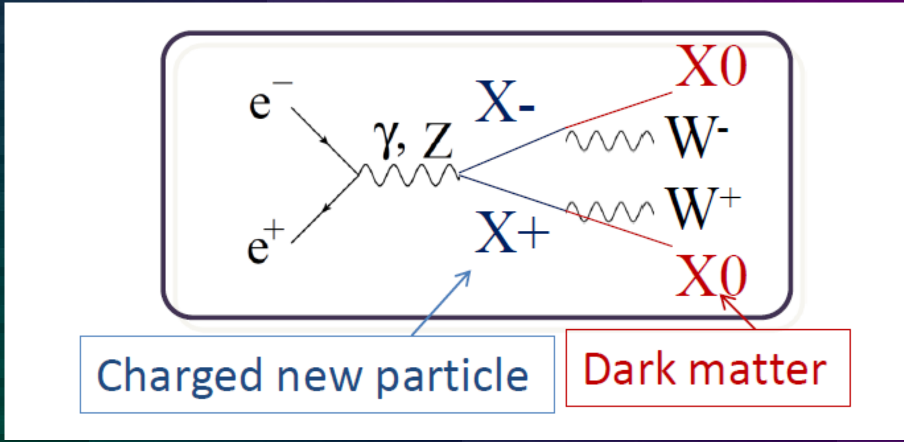


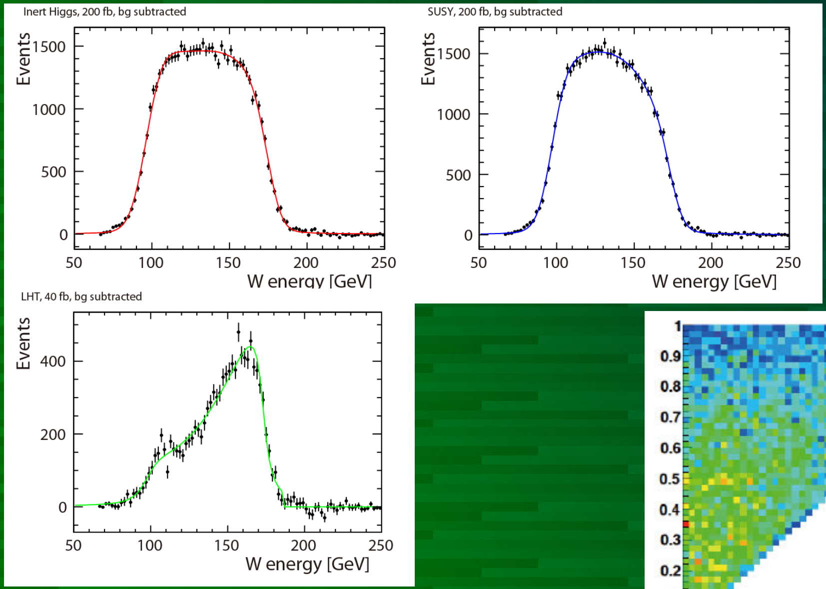
Model-ID Talks

M. Asano, T. Suehara

There are several models in which charged new particle decays to DM + W: separate the models by spin information.

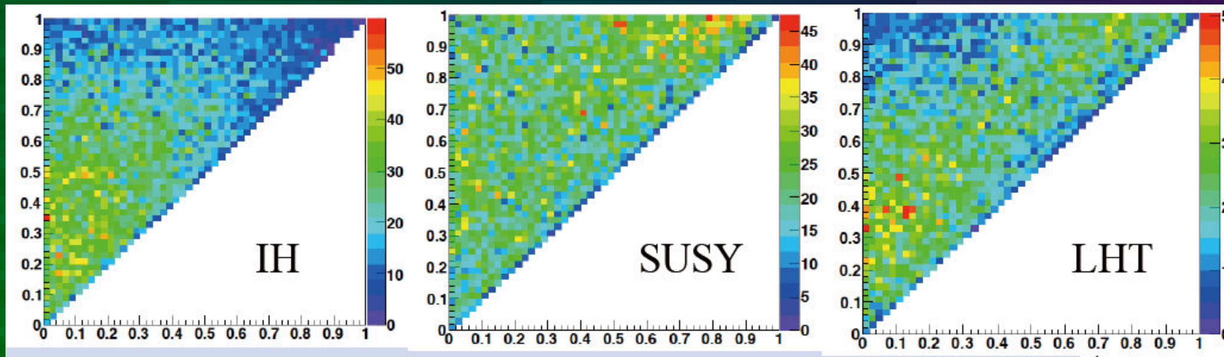
1. Inert Higgs (scaler)
2. SUSY (fermion)
3. Little Higgs with T-parity (vector)





Mass determination

Production angle (incl. 2-fold ambiguity)

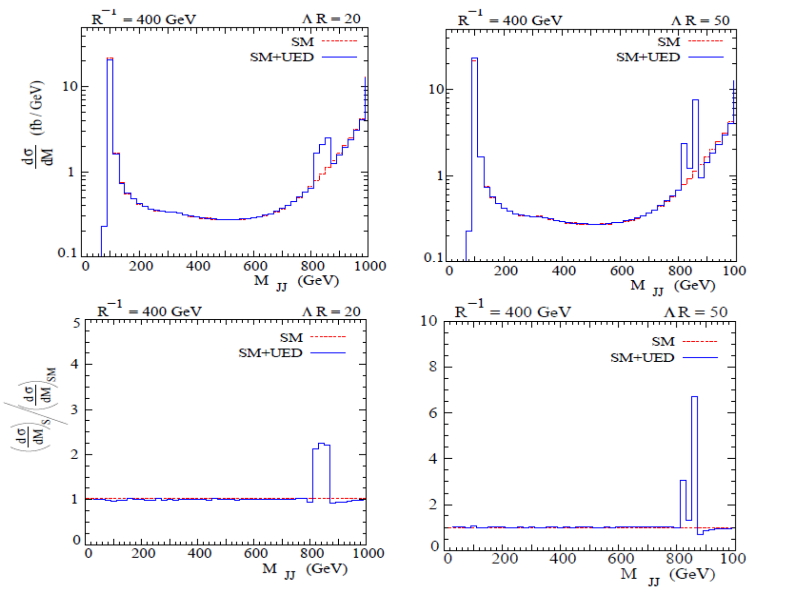


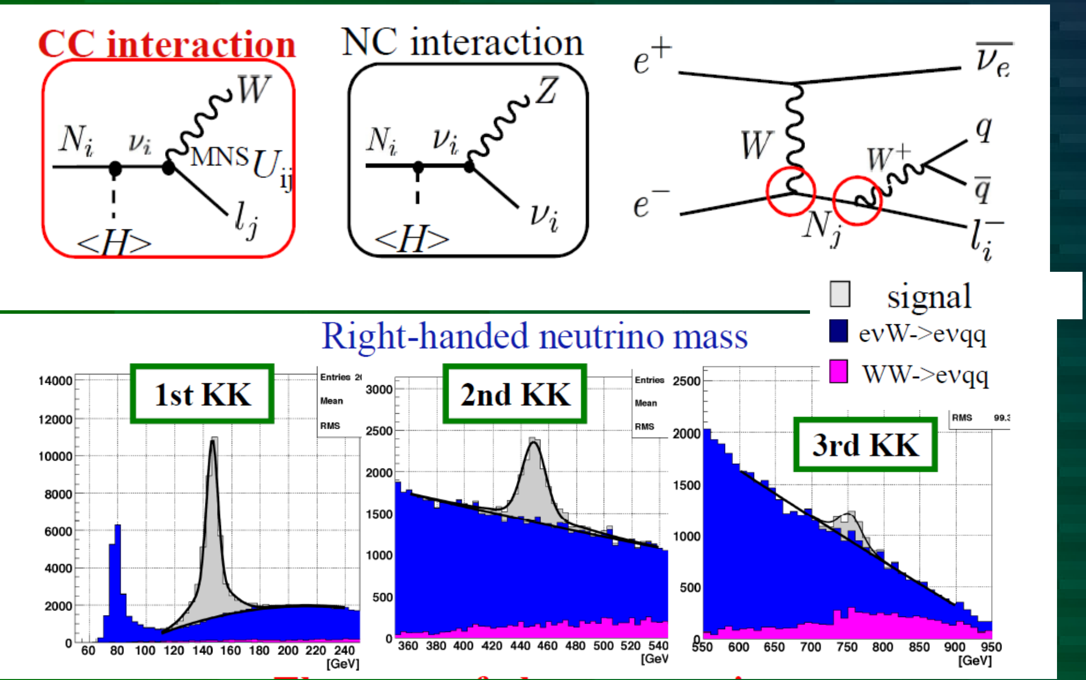
UED Talks

B. Bhattacherjee, T. Saito

2 UED related talks (1 theorist, 1 experimentalist)

1. Minimal UED with llqq + missing
2. Right handed neutrino





1 TeV collider, inverted or degenerated hierarchy

Other Theoretical Talks

Gauge boson self coupling

L. Guo

$$\mathcal{L} = +\beta_1 \frac{v^2}{4}\mathrm{tr}(V_\mu T)\mathrm{tr}(V^\mu T) + \alpha_1 g_2 \mathrm{tr}\left(\mathcal{W}^{\mu\nu} U \mathcal{B}_{\mu\nu} U^\dagger\right)$$
$$+ i\alpha_2 g_Y \mathrm{tr}\left(U^\dagger [V_\mu, V_\nu] U \mathcal{B}^{\mu\nu}\right) + i\alpha_3 g_2 \mathrm{tr}\left([V_\mu, V_\nu]\mathcal{W}^{\mu\nu}\right)$$
$$+ \alpha_4 \mathrm{tr}(V_\mu V_\nu)\mathrm{tr}(V^\mu V^\nu) + \alpha_5 \mathrm{tr}(V_\mu V^\mu)\mathrm{tr}(V_\nu V^\nu)$$
$$+ \alpha_6 \mathrm{tr}(V_\mu V_\nu)\mathrm{tr}(TV^\mu)\mathrm{tr}(TV^\nu) + \alpha_7 \mathrm{tr}(V_\mu V^\mu)\mathrm{tr}(TV_\nu)\mathrm{tr}(TV^\nu)$$
$$+ \frac{1}{4}\alpha_8 g_2^2 \mathrm{tr}(T\mathcal{W}_{\mu\nu})\mathrm{tr}(T\mathcal{W}^{\mu\nu}) + \frac{i}{2}\alpha_9 g_2 \mathrm{tr}(T\mathcal{W}_{\mu\nu})\mathrm{tr}(T[V^\mu, V^\nu])$$
$$+ \frac{1}{2}\alpha_{10}\mathrm{tr}(TV_\mu)\mathrm{tr}(TV^\mu)\mathrm{tr}(TV_\nu)\mathrm{tr}(TV^\nu) + \alpha_{11} g_2 \epsilon^{\mu\nu\rho\lambda}\mathrm{tr}(TV_\mu)\mathrm{tr}(V_\nu \mathcal{W}_{\rho\lambda}),$$

where $V_\mu \equiv D_\mu U \cdot U^\dagger$, $T \equiv U\tau^3 U^\dagger$.

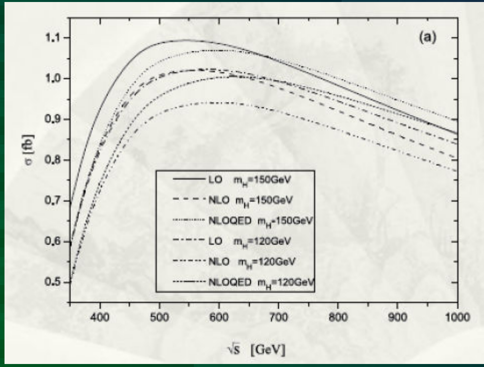
vertex	α_1	α_2	α_3	α_4	α_5	α_6	α_7	α_8	α_9	α_{10}	α_{11}	β_1	processes
$WW\gamma$	○	○	○					○	○				$\to WW,\ e\nu W$
WWZ	○	○	○					○	○		○	○	$\to WW,\ e\nu W$
$ZZWW$	○		○		○		○					○	$\to WWZ$
$ZWZW$	○		○	○		○						○	$\to WWZ$
$Z\gamma WW$	○		○									○	$\to WW\gamma$
$ZZZZ$				○	○	○	○			○			$\to ZZZ$

Many LO/NLO calculation for the ZZZ/WWZ are shown.

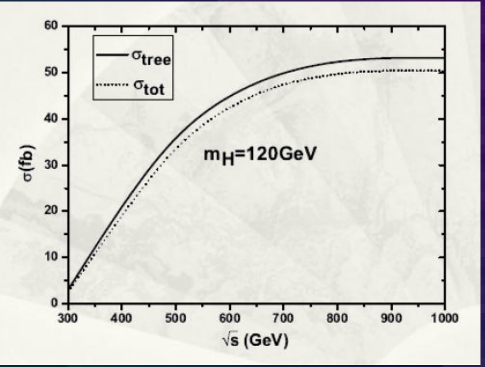
Left-right symmetric model

Y. F. Zhou

Decaying dark matter (long lifetime: > life of universe) with left-right symmetric model can explain dark matter, PAMELA/DAMA data without introducing artificial Z2 symmetry.



ZZZ cross section



WWZ cross section

SB2009 & New Physics

M. Berggren

Stau resolution

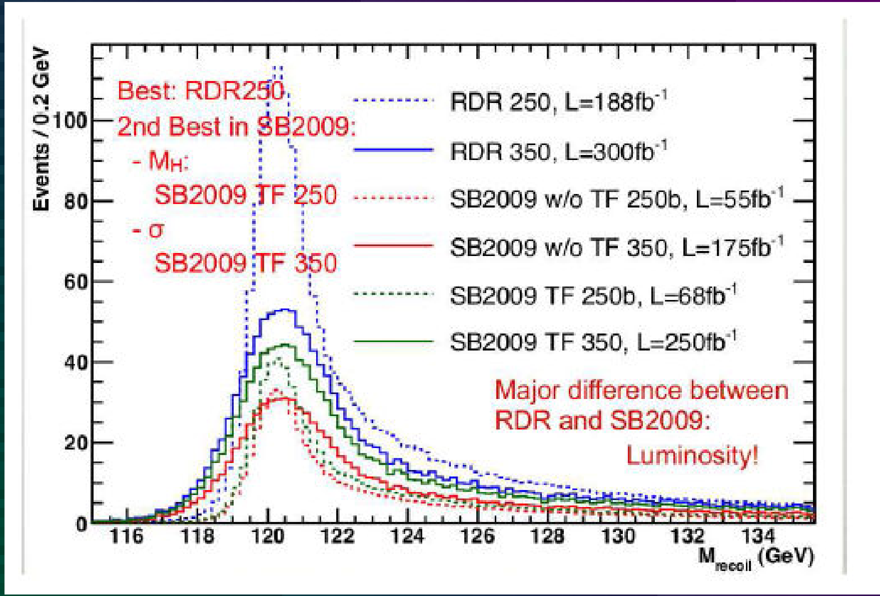
Errors on end-point (GeV)

case	#	$\tilde{\tau}_1$	$\tilde{\tau}_2$
RDR	1	0.129	1.83
+SB bck	2	0.144	2.02
+SB ppol	3	0.153	2.06
+SB spect	4	0.152	2.10
+SB noTF	5	0.179	2.42

Errors on cross-section (%)

case	#	$\tilde{\tau}_1$	$\tilde{\tau}_2$
RDR	1	2.90	4.24
+SB bck	2	3.03	4.72
+SB ppol	3	3.31	4.77
+SB spect	4	3.52	5.09
+SB noTF	5	3.79	5.71

Higgs recoil mass



SB2009 significantly degrades performance for some physics channels.

(My feeling) Most of us don't know why we stick to the SB2009 with much deficit and little financial gain.
Anyway, LHC will change everything…

Summary of Summary

- We have been longing for the LHC results… new physics will probably/perhaps/possibly(?) come next year!

- We should be ready for the LHC results… there are so many possibilities/models/parameters for explanation of the nature! Need more work!!

重要 至急

谢谢！

Be ready for